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PATENT SPECIFICATION

DRAWINGS ATTACHED

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Int. Cl.:—B 23 k // H 01 r

COMPLETE SPECIFICATION

Improvements relating to Welding a Contact to a Thermoplastic-Insulated Conductor

We, ELCO CORPORATION, a corporation organized and existing under the laws of the Commonwealth of Pennsylvania, of Maryland Road and Computer Avenue, County of Montgomery, Commonwealth of Pennsylvania, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement.:—

This invention relates to a process for welding a thermoplastic-insulated conductor to the tail of a contact and to a thermoplastic insulated conductor welded to a contact.

The need for this invention arises from the introduction into the electrical and electronic industries of ribbon cable which is a flat, elongated strip of thermoplastic material that surrounds a plurality of separate, generally flat or ribbon-shaped conductors spaced across the width of the strip. In order to terminate a length of cable in a connector, it is necessary to attach each conductor in the cable to an external conductor in the form of a contact. Heretofore, it has been the practice to prepare the cable by removing the thermoplastic insulation on one or both sides of a conductor to expose the same and then to solder or weld the exposed conductor to the tail of a contact. Alternatively, it has been the practice to utilize an external conductor shaped so as to pierce the thermoplastic insulation and mechanically and electrically engage the conductor in the cable. Neither of these methods has proved entirely satisfactory, and the present invention contemplates a method of welding a thermoplastic-insulated conductor to the tail of a contact by means of a two-step process.

In embodiments of the invention, prior to the first step, the tail of the contact is dimpled to raise a rounded projection on one surface of the tail and make a depression on the opposite surface, and a ribbon cable is then placed between said one surface of the tail and a movable electrode in alignment with a conductor in the cable. When so positioned, the electrode and the projection are urged into opposite surfaces of the thermoplastic insulation of the cable as the latter is squeezed between the electrode and the tail of the contact. When the electrode has a single point, it is aligned with the projection; and when the electrode is bifurcated to provide spaced points, the latter straddle the projection. The first step involves simultaneously heating the movable electrode to a temperature sufficient to soften the thermoplastic insulation, and squeezing the cable between the heated electrode and the tail of the contact. The heat from the electrode is transferred into the thermoplastic insulation causing it to soften in a region adjacent the electrode thereby permitting the latter to penetrate the softened insulation and electrically engage the conductor embedded in the insulation. The heating and pressure continue until the thermoplastic insulation between the conductor and the projection on the tail of the contact also softens permitting the projection to penetrate the softened insulation and electrically engage the conductor. At this time, the conductor is electrically engaged on one side by the movable electrode, and on the other side by the projection on the tail of the contact. The metallic junction established by the engagement of a flat conductor with the rounded projection has an inherently small cross-section so that when the second step thereafter occurs namely passing welding current through the electrode and the contact tail, the current density at the metallic junction is very high. This results in rapid heating of the junction and achieves a strong weld between the conductor and the tail of the contact.

The flow of welding current may be controlled by a timing device to occur after a predetermined time of squeezing the conductor between the electrode and the tail of the contact sufficient to guarantee that a proper junction is established between the heated elec-

[*Pri*

trode, [redacted]ontact, and the conductor in the ribbon cable. As an alternative form of the invention, the timing device may be replaced with an electric sensing device which measures the resistance between the contact and the heated electrode or between the contact and the particular ribbon cable involved. In this form of the invention, the flow of welding current occurs when the resistance becomes low enough to warrant the making of a weld. This decrease in resistance also indicates when the weld has been made.

Objects of the invention and its attendant advantages will be readily appreciated by referring to the following detailed description when considered in connection with the accompanying drawings, wherein:

Fig. 1 is a schematic view showing a ribbon cable in section positioned between a movable and heated welding electrode on one side and the tail of a contact on the other, a capacitor discharged type of welding circuit being connected across the movable electrode and the contact;

Fig. 2 is an enlarged fragmentary view of the elements shown in Fig. 1 after the initial stage of the first step of the welding operation has occurred, e.g., after pressure has been applied to the heated electrode and it has penetrated the softened insulation of the cable into engagement with the conductor in the cable;

Fig. 3 is a view similar to Fig. 2 but showing the elements after the final stage of the first step of the welding operation has occurred, e.g. after the heat from the heated and movable electrode has softened the insulation between the conductor in the cable and the tail of the contact and the conductor and contact tail are engaged;

Fig. 4 is a schematic view partially in section showing the completed securement of the contact to the ribbon cable with the depression in the insulation in the top of the cable, caused by the heated electrode, being filled-up with insulation material to protect the weld.

Fig. 5 is a view somewhat similar to Fig. 1 but showing a modified movable electrode and a modified contact;

Fig. 6 is somewhat similar to Fig. 3 and shows a completed weld; and

Fig. 7 is an enlarged underside view of the terminals welded by the method of Fig. 5.

Turning now to the various figures of the drawing wherein like reference characters refer to like parts the basic setup illustrating the apparatus for carrying out the present invention is generally illustrated at 10 in Fig. 1. As shown in Fig. 1, a contact 12 having an extending rounded projection 14 on its tail portion, is about to be electrically and mechanically united to a flat conductor 18 in ribbon cable 16.

The projection 14 on the tail of contact 12 facilitates penetration of the contact into the therm[redacted]c insulation of the ribbon cable. In a preferred embodiment of the invention, the projection 14 is approximately 0.030 inches in diameter and 0.020 inches in height.

Apparatus for carrying out the invention includes a movable electrode and welding control means operatively associated with the electrode. Movable electrode 20 is heated by well-known heating means (not shown) such as by a resistance heater embedded in the electrode, or by induction heating means. Electrode 20 includes base 22 from which depends heating finger 24, the free end of which actually engages the ribbon cable 16 and eventually softens and passes through the thermoplastic insulation and engages a conductor 18. To maintain heating finger 24 at a precise predetermined temperature, thermocouple 26 is associated with the finger, as shown in Fig. 1; and the thermocouple is operatively associated with the heating means in a conventional manner.

Connected across the electrode and the contact 12 is a condenser discharge circuit that is operable, after conductor 18 is engaged on one side by finger 24 and on the other side by projection 14 to dump welding current through the electrodes upon the closing of switch 31. Such welding current is effective to weld conductor 18 to projection 14.

The condenser discharge circuit comprises a plurality of capacitors 32, 34, and 36 connected in parallel by leads 42 and 44. One side of the capacitors, represented by lead 44, is connected by lead 38 to the body of contact 12. The other side of the capacitors, represented by lead 42, is connected via leads 40 and 41, and switch 31 to the electrode 20. Switch 30 is used to connect a regulated power supply across the capacitors by means of resistor 28. When switch 31 is open and switch 30 is closed, the power supply is effective to charge the capacitors, the time period necessary to effect charging depending upon the values of the resistor and the capacitors. After the capacitors are charged, switch 30 may be opened, and the capacitors can then be discharged to deliver welding current to the electrode 20 and the contact 12 when switch 31 is closed. Whereupon, the cycle of charging and discharging the capacitors can be repeated.

In carrying out the process of the present invention, the heated electrode 20 is brought to a desired temperature depending upon (a) the softening and scorching point of the thermoplastic insulation of the ribbon cable, (b) the thickness of the cable, (c) the pressure to be applied to the heat source and (d) the desired time of the operation.

In a preferred embodiment of the invention the ribbon cable was comprised of a polyethylene insulation material with a total thickness of 0.010 inches including a conductor thickness of 0.004 inches. The heat source 20 was maintained at approximately 250 degrees Celcius

which is l[illegible]nough to prevent scorching of the polye[illegible]ne in the relatively short contact time of five seconds, with a pressure of seven pounds being applied by the electrode heat source.

As shown in Fig. 1, the heated electrode 20 is moved downwardly in the direction of arrow 46 so that the nose 48 of the hot finger is about to contact the insulation on the outer face 50 of the ribbon cable 16. The nose 48 of the hot finger 24 may be bifurcated in order to provide two penetrating points.

As the hot nose 48 of the finger 24 comes in contact with the outer surface 50 of the ribbon cable 16, it immediately heats the neighboring insulation, the combination of heat and pressure of the nose 48 causing the insulation to soften and move sideways under the heat and pressure of finger 24. This permits electrode 20 to readily penetrate through the outer surface 50 until it reaches conductor 18 as illustrated in Fig. 2. At this stage, conductor 18 and projection 14 on contact 12 are separated from each other by a layer of thermoplastic insulation. Heat from the heated electrode now penetrates through the conductive member 18 and then finally to the inner face 52 of the ribbon cable thereby softening the insulation adjacent the projection 14 of the contact 12. The combination of the softened insulation adjacent the inner surface 52 and the pressure imposed by the heated electrode 20 enables the projection 14 readily to penetrate through the inner surface 52 until it comes in contact with the ribbon cable conductor 18 as shown in Fig. 3 establishing a metallic junction between the electrode 20, the ribbon cable conductor 18, and the contact 12.

At this point a condenser discharge is sent through the foregoing metallic junction in order to establish a weld between the conductor 18 and the projection 14 on contact 12. The condenser discharge is produced through the combination of the regulated power supply, the capacitor 32, 34, and 36 and the other circuitry of Fig. 1 in a manner already described.

As previously discussed, a timer may be associated with the switch 30 in order to complete the circuit of Fig. 1 after a predetermined time that is long enough to guarantee establishment of a metallic junction between the heat source, ribbon cable conductive member and connector terminal. This is done by mechanically associating (not shown) switch 31 with switch 30. Appropriate relays may be employed if desired. In a preferred embodiment of the invention the switch 30 may be closed manually, or by a microswitch arrangement whereby downward movement of electrode 20 closes a microswitch. Closing of switch 30 actuates the timer which closes switch 31 after a predetermined time to complete the power circuit.

The condens[illegible]charge can occur in a "dumping" arra[illegible]ient as previously described with switches 30 and 31 then opening to complete the cycle.

While a condenser discharge is preferably utilized to establish the weld, it is also contemplated that other power-arrangements may be utilized.

In the embodiment of Figs. 5, 6 and 7, the nose 148 of heated electrode 120 has but a single tip and is not bifurcated at the nose 24 of Fig. 1 but the electrode 20 may alternatively, be used. Also, the projection 114 in the contact is punched into the contact tail as indicated by depression 160. As shown in Fig. 5, the heated electrode 120 possesses a rounded point so that the center thereof will penetrate more readily into the insulaton.

The heated electrode 120 acts upon ribbon cable 16 with conductors 18 much in the manner of the heat source 20. A support base or anvil 162 is provided and this arrangement may also be utilized in the method of Fig. 1. Also, the contact 12 can be secured in an insulating casing 164 although this is usually done subsequent to welding.

After the last step in the process, the heated electrode can be withdrawn as shown in Fig. 6 whereby a depression 166 is created by the action of the electrode 120. Two depressions are also created when electrode 20 is used because of the bifurcated nature of the free end of finger 24. However, the single depression created when electrode 120 is used, or the two depressions created when electrode 20 is used, may be filled with epoxy or other sealing materials.

An enlarged view of the underside of a completed assembly is shown in Fig. 7, with welds 168 having been produced by the method of the present invention.

It is clear that the process of the present invention produces a weld connection between the connector terminal and the ribbon cable conductive member in a simple and efficient manner. Such a weld connection may not be strong enough physically to withstand the stresses imposed upon the ribbon cable in use. Therefore, mechanical means may be associated with the welded joints of the present invention in order to protect them. Such mechanical means may involve well-known mechanical strain release techniques or may utilize epoxy materials in order to strengthen the weld joints. Epoxy is also used to fill in depression 166 as previously noted.

WHAT WE CLAIM IS:—

1. A process for welding a thermoplastic-insulated conductor to the tail of a contact comprising the steps of: providing a projection on one surface of the tail of the contact, placing the insulated conductor between said one surface of the tail of the contact and a movable electrode so that the electrode and the projection are urged into the thermoplastic

insulation when the insulated conductor is squeezed between the electrode and the tail of the contact, heating the electrode while squeezing the insulated conductor between the electrode and the tail of the contact for softening the thermoplastic insulation between the electrode and the conductor to permit the electrode to penetrate the insulation and engage the conductor, and for softening the thermoplastic insulation between the conductor and the projection on the tail of the contact to permit the projection to penetrate the insulation and engage the conductor establishing a metallic junction between the conductor and the projection on the tail of the contact, and then causing welding current to flow through the electrode and the metallic junction between the conductor and the projection on the tail of the contact thereby welding the conductor and the projection together.

2. A process according to claim 1 wherein the projection is provided by dimpling the tail to raise the projection on one surface and to produce a depression in the tail on the opposite surface.

3. A process according to claims 1 or 2 wherein the projection is rounded and the conductor is flat whereby the metallic junction therebetween has a relatively small cross-sectional area.

4. A process according to claims 1, 2, or 3 wherein the electrode has a point that is aligned with the projection on the tail of the contact when the insulated conductor is squeezed between the electrode and the tail of the contact.

5. A process according to claims 1, 2, or 3 wherein the electrode is bifurcated to define spaced points that straddle the projection on the tail of the contact when the insulated conductor is squeezed between the electrode and the tail of the contact.

6. A process according to any of claims 1—5 wherein the flow of welding current occurs after the insulated conductor has been squeezed between the electrode and the tail of the contact for a predetermined period of time long enough to guarantee that the electrode engages the conductor and the projection engages the conductor to establish the metallic junction.

7. A process according to any of claims 1—5 wherein the flow of welding current occurs when the resistance between the contact and the heated electrode or between the contact and the conductor becomes low enough to warrant the making of a weld.

8. A termination for a conductor having thermoplastic insulation comprising a contact having a tail that is dimpled to raise, on one surface thereof, a projection that penetrates the thermoplastic insulation and makes a metallic junction with the conductor, said conductor being welded to the tail at the metallic junction therebetween.

9. A termination according to claim 8 wherein the conductor is flat.

10. A process for welding a thermoplastic-insulated conductor to the tail of a contact substantially as described hereinbefore with reference to the accompanying drawings.

11. A termination for a conductor substantially as described hereinbefore and as shown in the accompanying drawings.

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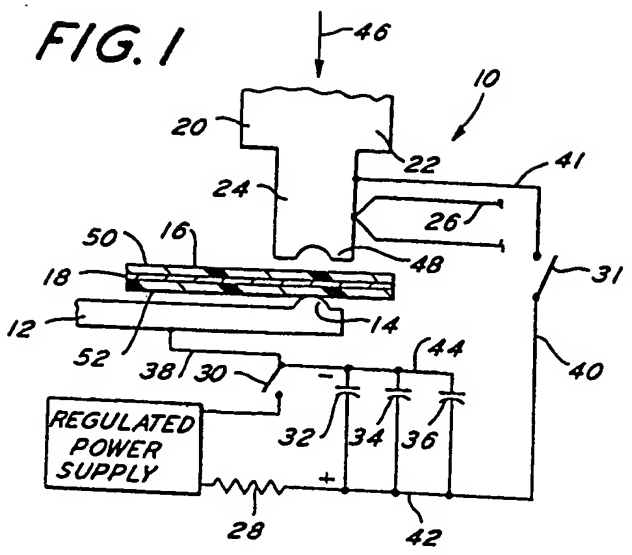
FIG. 1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REGULATED POWER SUPPLY
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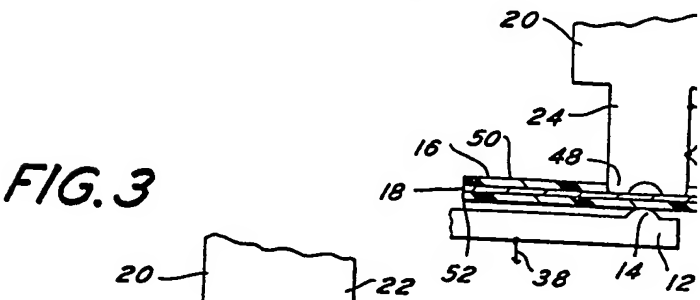
34
36
28
42

FIG. 3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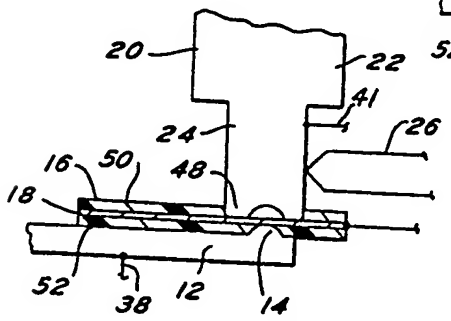
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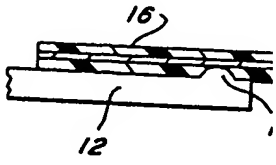
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2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheets 1 & 2

FIG. 5

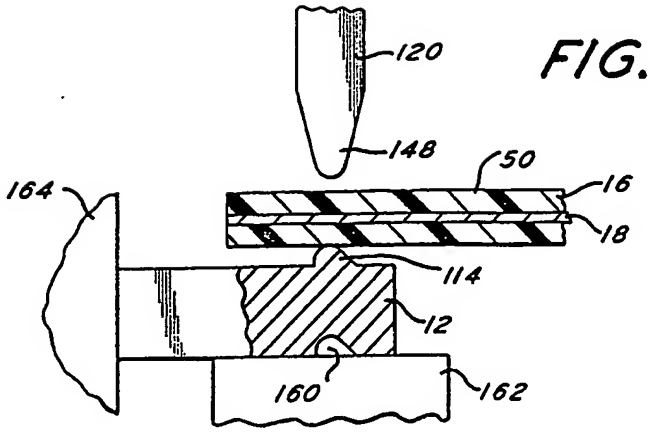


FIG. 2

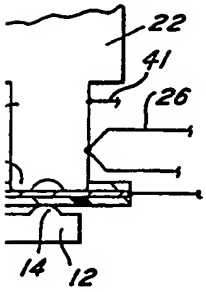


FIG. 6

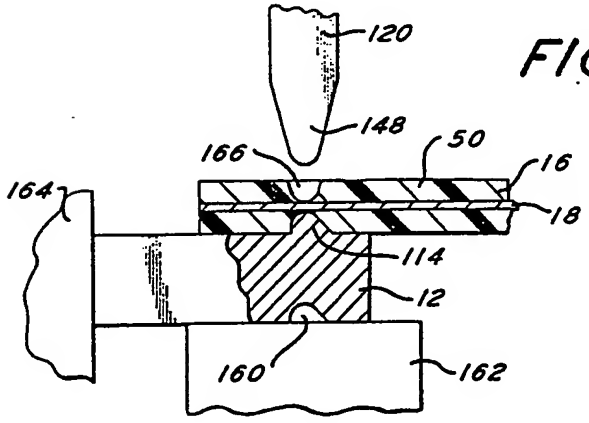
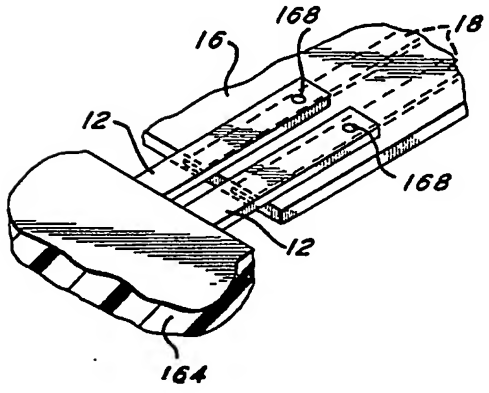


FIG. 4

FIG. 7



1075799 COMPLETE SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheets 1 & 2

FIG. 1

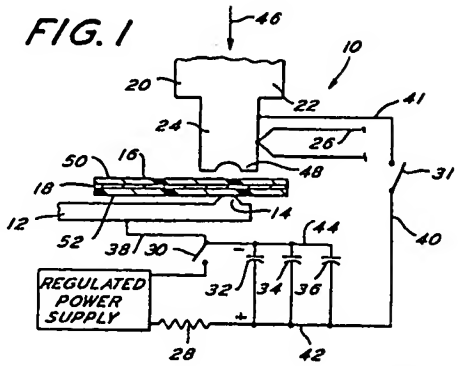


FIG. 2

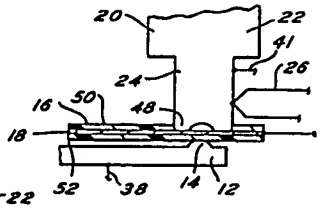


FIG. 3

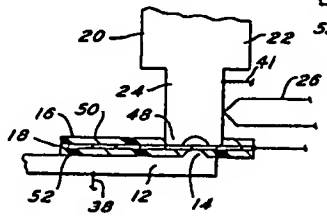


FIG. 4

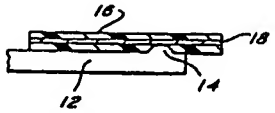


FIG. 5

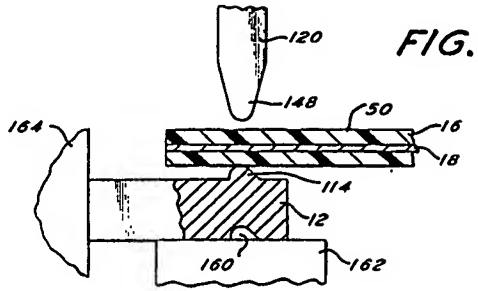


FIG. 6

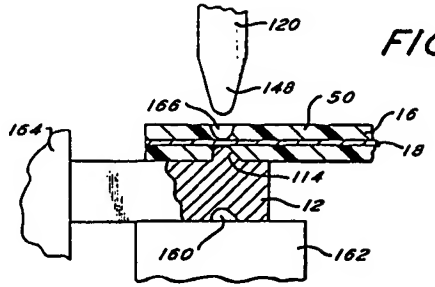


FIG. 7